

Event Tagging & Filtering

PHENIX Level-2 Trigger

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Introduction

The PHENIX Level-2 is a software-based trigger which runs in the scope of the PHENIX Event Builder of the PHENIX data acquisition system. The first online implementation of the PHENIX Level-2 was for the second RHIC run in 2001/2002 and its results was published in NIM A409 560-592 (2003). The Level-2 trigger provides the capability for the PHENIX experiment to do event tagging and filtering online based on potential physics interests. The Level-2 trigger algorithms are developed and tested in an offline framework before being integrated into the Event Builder. The infrastructure of the Level-2 trigger which includes its offline development framework, online configuration and monitoring will be presented in this poster.

PHENIX Challenge

- “Rare” physics program
- High data rate
- Complex particle detectors:

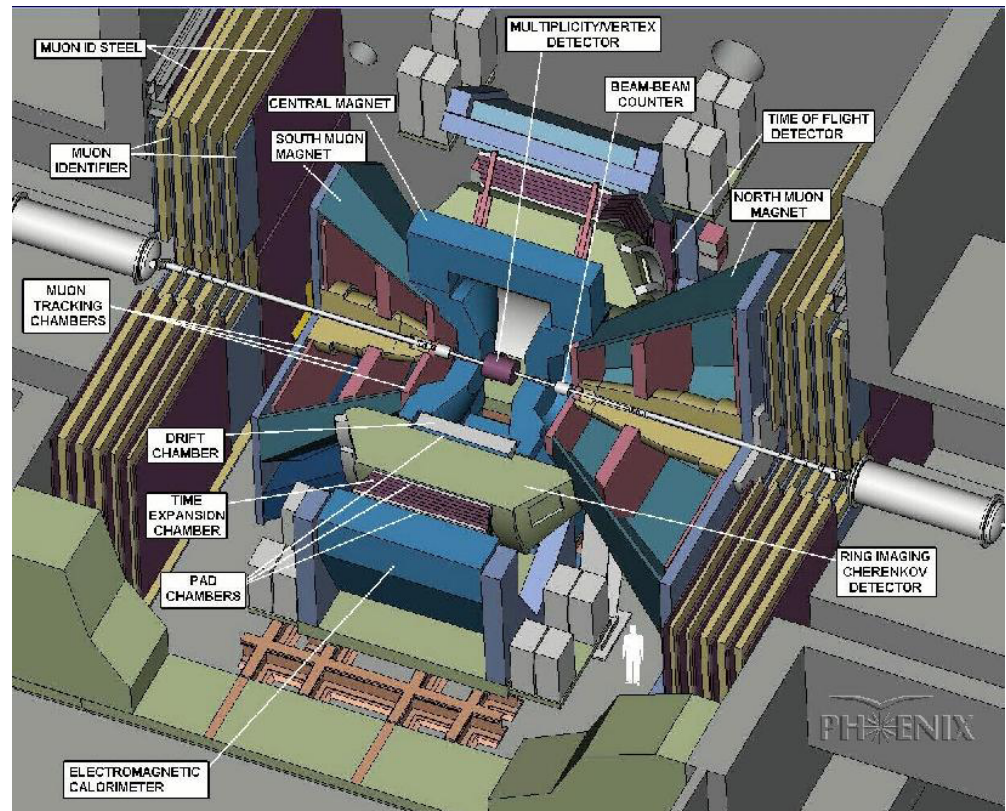
4 spectrometer arms

12 Detector subsystems

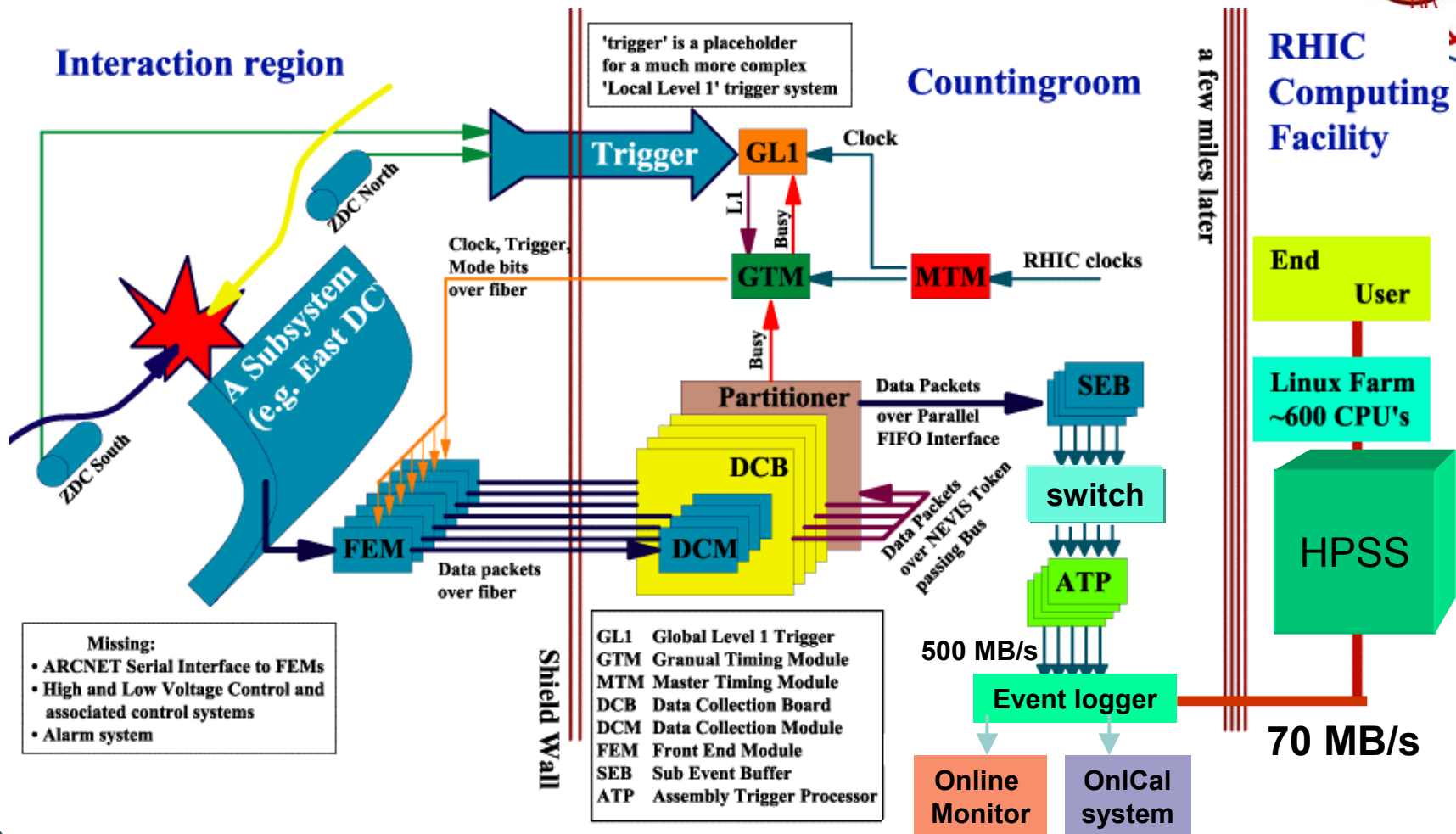
350,000 detector channels

Lots of readout electronics

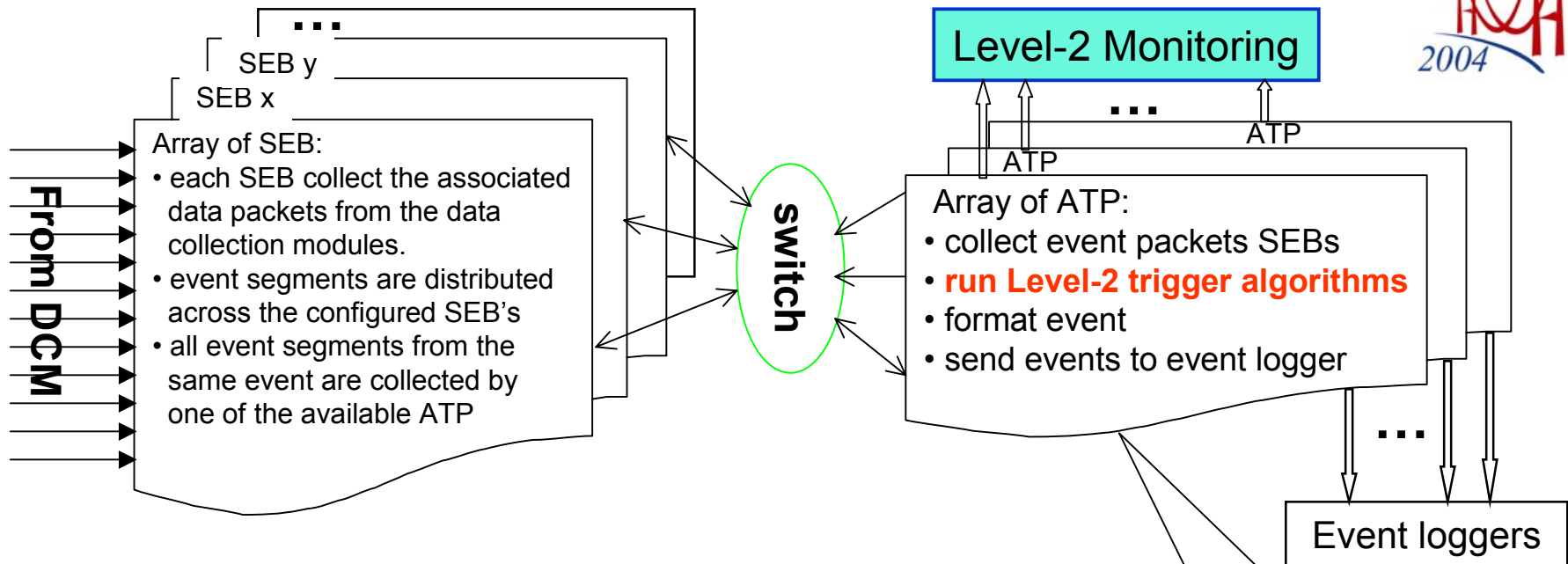
<http://www.phenix.bnl.gov/>



PHENIX Online System



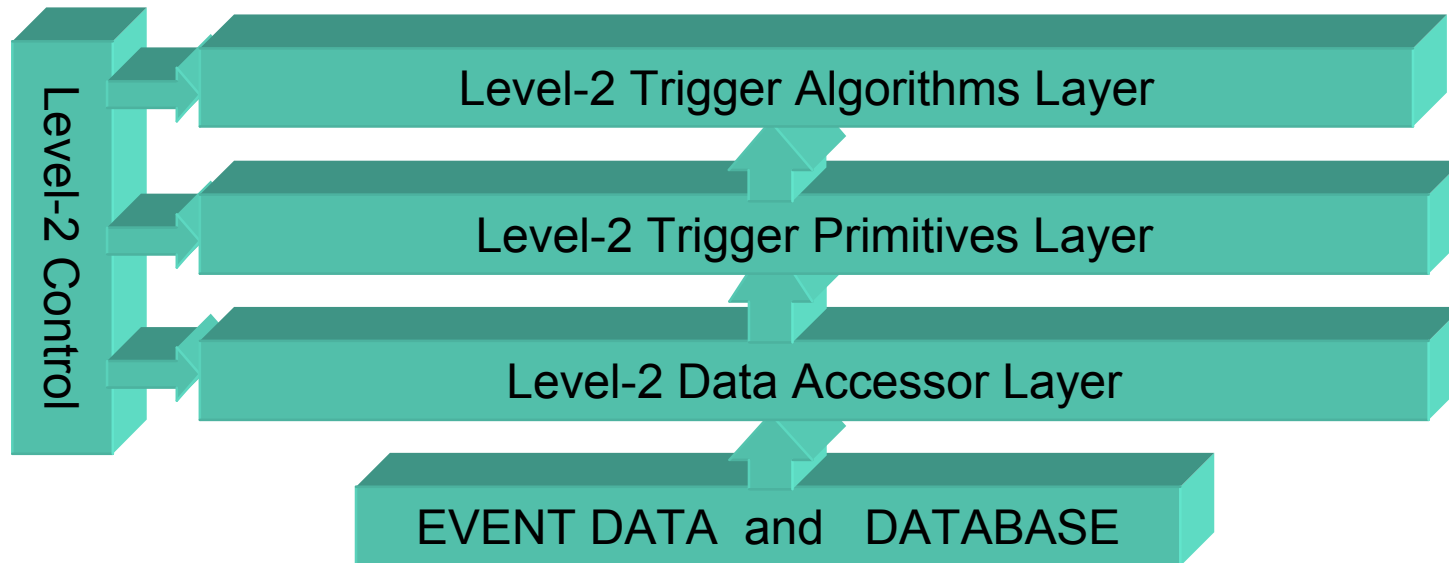
PHENIX Event Builder



PHENIX Level-2 trigger algorithms run on each Assembly and Trigger Processor (ATP) which is part of the PHENIX Event Builder components. Each ATP collects event segments from all Sub Event Buffer (SEB) nodes and sends each complete formatted event to the event logger.

Level-2 configuration parameters are sent to each ATP from Run Control before each run is started.

Level-2 Infrastructure



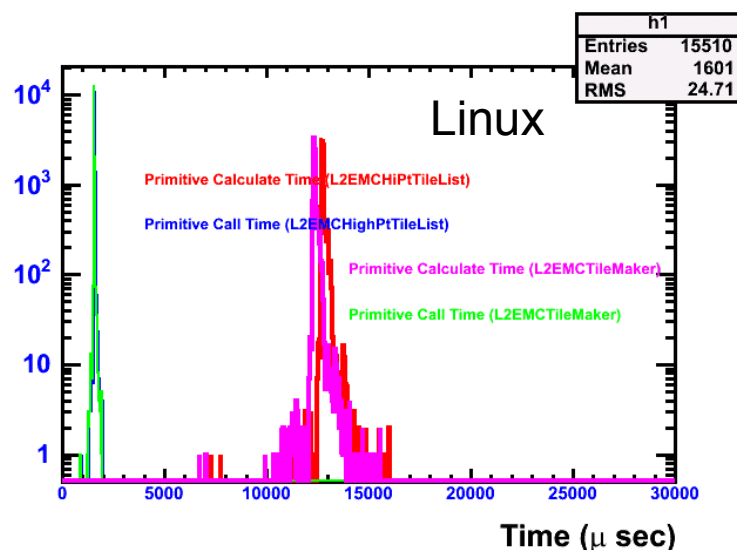
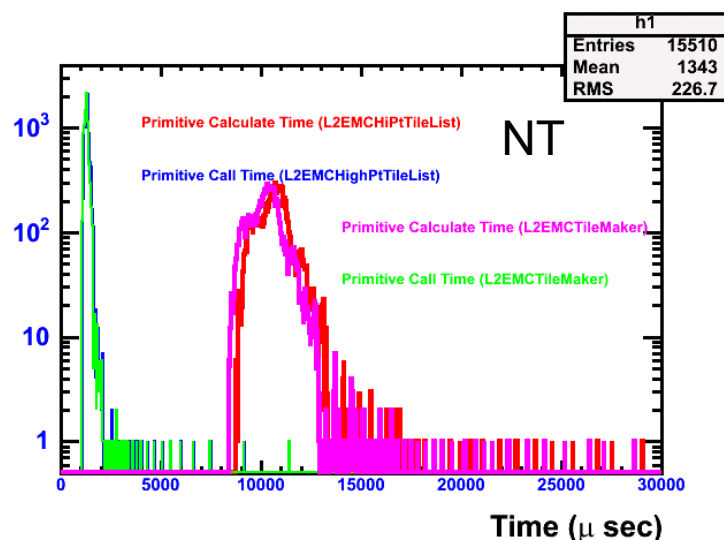
The Level-2 trigger code is written in C++ and can be viewed as different logical layers as shown above. Aside from the control class, each specific trigger class is derived from common template to enforce a common interface. For each event each trigger algorithm object is created which then accesses the associated trigger primitives. Each trigger primitive object is created once only and can be shared by multiple trigger algorithms for each event. The primitive objects access data accessor objects, database objects and other primitive objects. These objects only get instantiated under request. A Level-2 monitoring object is also created at the end of the each event processing and is passed to the remote monitoring process via direct Corba connection.

Level-2 Trigger in Run-2

- Level-2 trigger system was first implemented in Run-2 for 200 GeV Au+Au collisions.
- There were seven trigger algorithms (which included single electron, electron pair, single deep muon, muon pair, high pT EMCal, High pT charged and coherent peripheral) each of them could use different threshold settings.
- The total Level-2 trigger processing time for a single event was found to be 31 ms (the design value is 25 ms). This was adequate for RHIC Run-2 with 32 ATP's active given the maximum DAQ throughput about 800 Hz.
- For Run-2, regular Level-2 monitoring was only done with events written to disk.
- In over all, the PHENIX Level-2 triggers worked well in Run-2.

Trigger Development System

Over the summer of 2003, a standalone Level-2 trigger development and test system was constructed both with Linux platform and NT which allows us to run the trigger algorithms and monitoring the trigger performance. This system greatly eases the process of integrate the Level-2 triggers into the PHENIX Event Builder and allows each trigger algorithm writer to fully debug and test it without needing the fully functional DAQ system. The histograms below show the example timing information obtained from this development system. The left one is the result from NT, and the right one from Linux.



Level-2 Configuration

Level-2 trigger parameters are configured via Run Control before a run is started. This configuration process sets the association between the Level-1 trigger bits and the Level-2 algorithms. It also sets the scaledown factors for each algorithm.

Level-2 Configuration

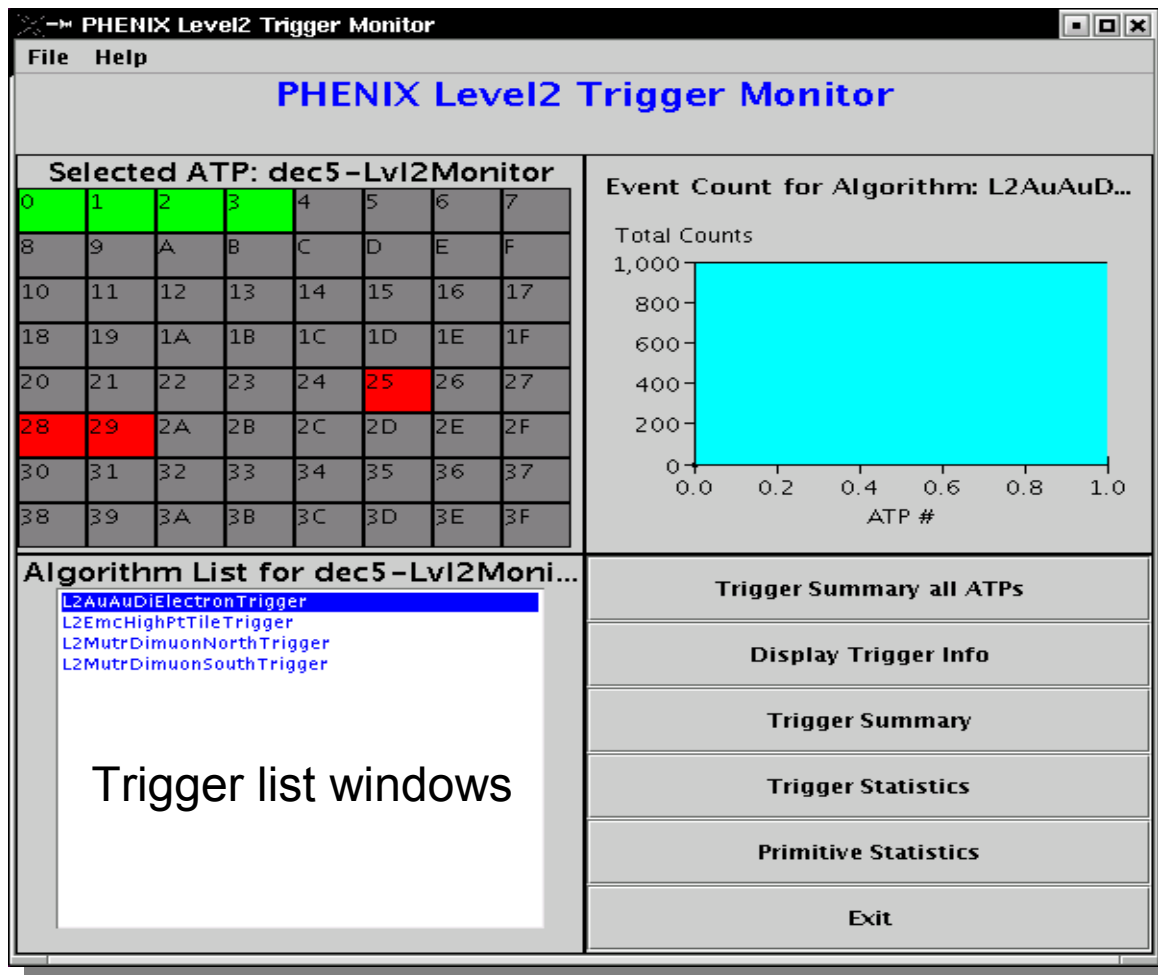
- Associate Level-1 bits to each Level-2 algorithm

- Set scaledown factors for each trigger algorithm

- Send configuring info to all trigger processors

- Save trigger configuration into database

Level-2 Monitoring



Note:

A screen snapshot of the Level-2 real-time performance monitoring windows.

- All running trigger processors (ATP's) are indicated with green box, gray boxes mean that the corresponding ATP's are not enabled and the red boxes indicate the enabled ATP's not responding.

Monitoring Primitives

Run # 1 ATP # 1 Primitive Statistics

Primitive Name	Primit...	Event Count	Error Count	Avg Event ...	Event Use Fraction
L2AuAuEM CalRichRingMatcher	V1	997	0	0.0103914...	1.0
L2AuAuElectronCandidate	V1	997	0	0.0460662...	1.0
L2AuAuElectronInvMass	V1	997	0	0.04655387	1.0
L2AuAuRichRingAssociator	V1	997	0	0.0376058	1.0
L2AuAuTwoPointTrackerEMC	V1	997	0	0.0248083...	1.0
L2BbcPrimitive	V1	997	0	6.1023573...	1.0
L2EMCHighPtTileList	V2	7976	0	0.0134000...	1.0
L2EMCHitTileList	V1	0	0	0.0	1.0
L2EMCTileMaker	V1	7976	0	0.0127929...	1.0
L2MuiSymsetCalcPerPanel	V1	31890	0	0.0302413...	1.0
L2MuiTracks	V1	1993	0	0.0155909...	1.0
L2MutrClusterPrimitive	V1	13746	0	0.0032572...	1.0
L2MutrCoordPrimitive	V1	13745	1	0.0035918...	1.0
L2MutrPairPrimitive	V1	1979	14	0.03282888	1.0
L2MutrTrackPrimitive	V1	1979	14	0.0187382...	1.0
L2RichRingFinder	V1	997	0	0.0011173...	1.0

A snapshot of trigger primitive information from a given ATP (example only)

Trigger Summary Tables

The table below shows an example of the Level-2 trigger performance (averaged over all ATP's) of all trigger algorithms configured in a test system. The most useful information are:

- a) Accepted event count
- b) Average event processing time
- c) Trigger rejection factor

Level2 Trigger Summary Table							
AlgoName	Version	EventCount	AcceptCount	AveEvtTime	RejFactor	ErrCount	Bit Set
L2AuAuDiEl...	0.0	997	30	0.046608...	33.0	0	0
L2EmcHigh...	0.0	996	99	0.013878...	10.0	0	
L2MutrDim...	0.0	997	0	0.0147034	1000000.0	0	
L2MutrDim...	0.0	996	287	0.047168...	3.0	14	0

Level-2 Algorithms in Run-4

There will be four Level-2 trigger algorithms in Run-4

- Au+Au di-electron trigger
- High p_T electromagnet calorimeter trigger
- Muon North Arm di-muon trigger
- Muon North Arm di-muon trigger

Level-2 for Run-4

Currently we do not need Level-2 triggers since we can in principle archive everything that gets through the DAQ, which is about at least 250 MB/s (could be 500 MB/s). This is based on the facts that, on average, the expected RHIC luminosity will be $8 \times 10^{26} \text{ cm}^{-2}\text{s}^{-1}$ (note that it is currently seen $5 \times 10^{26} \text{ cm}^{-2}\text{s}^{-1}$) and assuming 50% vertex cut, the event rate will be 2500 Hz. The average event size is less than 200 KB.

The Level-2 trigger for Run-4 (without rejection) will be enabled in the week after Quark Matter 2004. Each recorded event will be tagged with Level-2 processing information. It will not only allow us to make prompt online physics monitoring but also enable us to speed up offline data analysis via event filtering.